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The MONITOR

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The MONITOR is a quarterly publication of the Headquarters Air Force Materiel Command (AFMC) Pollution Prevention Integrated Product Team (P2IPT) dedicated to integrating environment, safety, and health related issues across the entire life cycle of Air Force Weapon Systems. AFMC does not endorse the products featured in this magazine. The views and opinions expressed in this publication are not necessarily those of AFMC. All inquiries or submissions to the MONITOR may be addressed to the Program Manager, Mr. Frank Brown.

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JG-PP Success Story: The Nonchromated Primer for Exterior Aircraft Project Completes the Demonstration/Validation Phase

In January 2002, the Joint Group on Pollution Prevention (JG-PP) completed the Nonchromated Primer For Exterior Aircraft Project and held a final meeting with stakeholders at Tyndall AFB to discuss the results of the Final Joint Test Report (JTR) (see related article on page 6). This article provides a historical overview of this project that started in May 1995 and has completed four phases of the JG-PP methodology (JG-PPMET).

The JG-PPMET was initially developed in 1994 in response to JG-PP's original charter to implement pollution prevention projects at OEM sites. JG-PPMET has also proven to be a valid process for implementing projects in the sustainment community. JG-PPMET has integrated the participation of both business and technical stake-holder at key milestones to ensure the successful implementation of material/process changes across a wide spectrum of weapon and space systems and partners. The historical results from the JG-PP Nonchromated Primer for Exterior Aircraft Project are summarized below.

Project Background

Table 1 identifies the target hazardous materials, baseline process, application, current specification, weapon systems impacted and candidate substrates that were addressed the by the JG-PP Nonchromated Primer for Exterior Aircraft Project. Chromium in primer coatings was identified as the target hazardous material (HazMat) to be eliminated or reduced at Boeing's Military Aircraft and Missile Group (B-A&M). Chromated primers are applied by wet-spray coating to aircraft exterior mold line skins. The primary substrate is aluminum alloy that was anodized or chromate conversion coated. Other substrates on the aircraft exterior surface include steel, carbon epoxy, and titanium.

Table 1. Target HAZMAT Summary

Target HAZMAT	Baseline Process	Application	Current Specifications	Current Specifications	Candidate Substrates
Chromium	Primer Application by Wet-Spray Coating	Exterior Aircraft Mold Line Skins	MIL-P-23377 Class C MIL-P-85582 Class C2 MMS 423A DMS 2104E DMS 2144C	Air Force: F-15, C-17, C-130 Navy: F/A-18, T-45, TX, Harpoon/SLAM Marine Corps: AV-8B	• Aluminum alloy 2024-T3; bare and clad; conversion coated, anodized, or deoxidized • Aluminum alloy 7075-T6; bare and clad; conversion coated or anodized • Aluminum alloy 2014-T6, clad, conversion coated • Steel alloy 4130; cadmium plated or IVD A1 coated • Titanium alloy Ti-6A1-4V • Magnesium alloy AZ 312B • Carbon Epoxy

Development of the Potential Alternatives Report (PAR) and Joint Test Protocol (JTP)

Figure 1, on the next page, summarizes the baseline primer spray application process currently used at B-A&M. Chromated-containing primers are sprayed on aircraft exterior mold line skins in spray booths. One or two coats of primer are applied as required to achieve a coating thickness of 0.8 mil to 1.4 mil for interior surfaces and 0.4 mil – 0.8 mil for exterior surfaces. B-A&M currently uses approximately 2,000 gallons per year of chromate-containing primers for application to aircraft exterior mold line skins. Additional information on the baseline process is contained in the Potential Alternatives Report (MD-A-1-1) for *Alternatives to Chromate-Containing Coatings for Aircraft Exterior Mold Line Skins*, dated May 1, 1998.

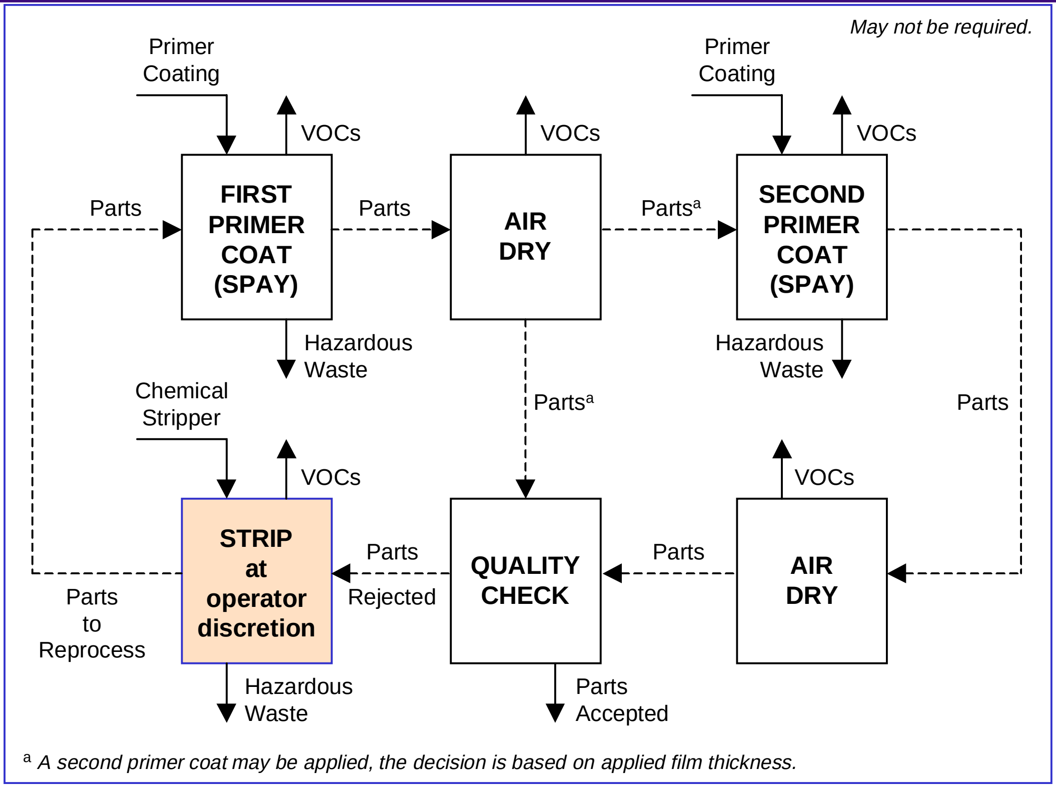


Figure 1. Primer Spray Application Flow Diagram

The PAR identified 17- high-solids or waterborne nonchromate primers, as well as one electrocoat nonchromate primer (as shown in Table 2) for further screening in accordance with the Joint Test Protocol (dated December 27, 1997). Candidate nonchromate primers that did not meet the requirements of the screening tests were eliminated from further testing. Additional testing conducted on the remaining candidates included the following:

- **Naval Air Warfare Center (NAWC) qualification tests** represent the tests agreed upon by the technical representatives and performed by the NAWC laboratories. Most of these tests compared the performance of a screened, potential alternative primer to the requirements of the current MILSPECs for epoxy primers (MIL-P-85582B and MIL-P-23377G).

Table 2. Nonchromate Primers Selected for Screening Tests

Primer Type	Designation	Manufacturer
High-Solids	02-W-38	Deft, Inc.
High-Solids	10P22-3/EC-270	Dexter Aerospace Materials/Crown Metro Aerospace
High-Solids	Aeroglaze 9740	Lord Corporation
High-Solids	Aeroglaze 9741	Lord Corporation
High-Solids	EEAE136 A/B	Spraylat Corporation
High-Solids	U-1201-NC/U-1202-F	Sterling Lacquer Manufacturing Company
High-Solids	Alumigrip R1204/S3800	U.S. Paint Corporation
Waterborne	RW-3151-54	Courtaulds Aerospace
Waterborne	RW-3181-64	Courtaulds Aerospace
Waterborne	44-W-16	Deft, Inc.
Waterborne	44-W-17	Deft, Inc.
Waterborne	44-W-18	Deft, Inc.
Waterborne	10PW22-2/ECW-119	Dexter Aerospace Materials/Crown Metro Aerospace
Waterborne	10PW22-3/ECW-123	Dexter Aerospace Materials/Crown Metro Aerospace
Waterborne	EWDY048 A/B	Spraylat Corporation
Waterborne	EWAE118 A/B	Spraylat Corporation
Waterborne	U-4800-NC/U-4801	Sterling Lacquer Manufacturing Company
Electrocoat	02G28AD012	BASF Corporation

- **Adhesion tests** intended to demonstrate the ability of candidate nonchromate primers to adhere to various substrates and to other coatings with which the primer may be used, under a number of conditions.
- **Flexibility tests** intended to demonstrate the ability of candidate nonchromated primer to remain intact and adhere to various substrates when the substrate panels are bent or subjected to impact.
- **Corrosion tests** are intended to demonstrate the ability of candidate nonchromate primers to inhibit and/or prevent corrosion of metal substrates under various conditions.
- **Miscellaneous tests** that demonstrate a number of properties of candidate nonchromate primers such as application properties and resistance to degradation caused by heat, humidity, thermal shock, and exposure to various fluids.

Demonstration/Validation of Downselected Alternatives

Generally, the Alternative Demonstration/Validation Phase is the longest portion of the JG-PP process. This phase can vary from several months to several years of testing. During this phase, the required tests for the selected alternatives are conducted and the data analyzed. The results of the demonstration/validation are documented in the Joint Test Report (JTR).

For the Nonchrome Primer for Aircraft Exterior Project, the testing was carried out in three phases. The first two phases consisted of laboratory testing and the last phase of field evaluation. The *Joint Test Report* (MD-R-1-2) *for Laboratory Validation of Alternatives to Chromate-Containing Primer Coatings for Aircraft Exterior Mold Line Skins* documents the laboratory testing done in the first two phases. The first phase of testing involved 18 potential nonchromate primers. The preliminary testing results were then used to narrow down the number of nonchromate primers to 9 selected for further testing.

None of the nonchromate primers performed as well as the chromate control primers but the results of nonchromate primer testing were encouraging. After analyzing the results of the laboratory testing, two waterborne nonchromate primers were selected for field evaluation on operating aircraft. The two candidate alternatives were:

- Dexter Aerospace Materials/ Crown Metro Aerospace 10PW22-2/ECW-119
- PRC-DeSoto (formerly Spraylat Corporation) EWAE118 A/B

The two primers that were selected passed the most corrosion, adhesion, flexibility, and miscellaneous tests. Field evaluation was conducted on F-15, F/A-18, T-45 TS, C-17, C-130, Harpoon/SLAM Canister, and AV-8B aircraft. Periodic inspections of the aircraft being used for the operational testing were documented in Field Evaluation Reports (FERs).

The results of the field evaluation testing were documented in another JTR, which was published in January 2002. The results indicate that using nonchrome primers that perform in laboratory tests equivalent to the original test results for the Akzo Nobel, 10PW22-2 and PRC-DeSoto EWAE118 could meet operational performance requirements without adverse cost to the operational units. However, adhesion failures on the F/A-18, that began to appear on carbon epoxy wing skins after three years is a concern that needs to be addressed.

Next Steps

The Air Force is planning to conduct an additional year of testing before making any decision regarding the use of the nonchromate primers on aircraft weapon systems.

The Air Force is currently implementing a follow-on project to continue the evaluation of nonchrome primers on the outer moldline of aircraft. The effort will include observance of application, field evaluation, data collection, documentation, and analysis of test results of nonchromated primers. Under the completed JG-PP project several weapon systems were evaluated including; F-18, AV-8, HARPOON canisters, T-45, F-15, C-17, C-130 aircraft. F-16 aircraft were also observed under a Lockheed-Martin project for Ogden Air Logistics Center, Hill AFB UT. This effort will target the KC-135 aircraft as well as continued monitoring of the F-15, F-16, C-130, and C-17. Some of the aircraft used in the JG-PP project will be due their six year strip and paint during this project. Therefore, it is imperative they be inspected after coating removal to identify any hidden corrosion masked by the coating system over its six year cycle.

For further information, please contact Mr. Steve Finley at HQ AFMC/LGP-EV at DSN 787-8090 or by e-mail at Steven.Finley@wpafb.af.mil.

Joint Group Pollution Prevention Host Nonchromate Primer for Aircraft Exteriors Project Final Report Meeting at Tyndall AFB

On 29-30 January 2002, a technical meeting was held to discuss the decisions made by the Navy and Air Force Systems Program Offices and MAJCOM users on the implementation of nonchromate primer. Table 3 provides a listing of the key stakeholders that participated in this technical meeting.

Table 3. Key Stakeholders at the JG-PP Non-Chromated Primer Final Report Meeting

Name	Office Symbol	E-mail Address
CMSgt Greg Stonelake	ACC/LGMS	gregory.stonelake@langely.af.mil
SMSgt Jerry Chaplin	AETC/LGM	jerry.chaplin@randolph.af.mil
John Lindsey	AFCPO Ofc	john.lindsey@robins.af.mil
SMSgt William Santiago	AFMC/DOM	william.santiago@wpafb.af.mil
Deborah Meredith	AFMC/LGP-EV	debora.meredith@wpafb.af.mil
Tom Naguy	AFRL/MLQL	thomas.naguy@wpafb.af.mil
F.D. Kisor	AFRL/MLSS	fkisor@flashjet.net
SMSgt Johnny Kingsley	AFSOC	johnny.kingsley@hurlburt.af.mil
MSgt Kurt Westergaard	AMC/LGMJS	kurt.westergaard@scott.af.mil
Lt Melanie Schlosser	ASC/FBAX	melanie.schlosser@wpafb.af.mil
John Stallings	ASC/GRE	john.stallings@wpafb.af.mil
Larry Triplett	Boeing, St. Louis	larry.triplett@boeing.com
Alan Lepper	Boeing, Long Beach	alan.l.lepper@boeing.com
SMSgt Ron McAtee	HQ AFRC	ron.mcatee@afrc.af.mil
James Whitfield	NADEP-Cherry Point	whitfieldja@navair.navy.mil
Tim Woods	NADEP-North Island	woodstr@navair.mil
Matt Rothgeb	NASA AP2	rothgmj@kscems.ksc.nasa.gov
Steve Spadafora	NAVAIR	spadaforasj@navair.navy.mil
Mike Martyn	NAVAIR-China Lake	martynml@navair.navy.mil
Dick Buchi	OC-ALC/TIELM	richard.buchi@hill.af.mil
Wayne Patterson	OC-ALC/TIELM	wayne.patterson@hill.af.mil
Fonda Wu	Raytheon	fwul@west.raytheon.com
John Stephens	WR-ALC/LFEFS	john.stephens2@robins.af.mil
Ryon Westover	NADEP-Jax	
Jack Benfer	NADEP-Jax	benferje@navair.navy.mil
Rod W. Richardson	USA-MP	richardsonr@usasrb.ksc.nasa.gov
Paul W. Hayes	USA-MP	hayesp@usasrb.ksc.nasa.gov
Paul J. Doyle	Westar Corp	doyle0415@aol.com
David Kessen	AFRL/CTIO	david.kessen@wpafb.af.mil
James P. Robinson	AMCOM/EELO-ET	james.robinson@redstone.army.mil
Stephan Wolanczyk	AFRL/MLSS (CTIO)	stephan.wolanczyk@afrl.af.mil
Major Joel Almosara	ASC/YCES	joel.almosara@wpafb.af.mil
Larry Garrett	WR-ALC/TIED	larry.garrett2@robins.af.mil
Wesley Lamb	NADEP-Cherry Point	lambwm@navair.navy.mil

Steve Finley, HQ AFMC/LGP-EV, who serves as the Nonchromate Primer For Aircraft Exteriors Project Manager welcomed the stakeholders and gave brief opening remarks. Ms. Debbie Meredith, HQ AFMC/LGP-EV gave a brief overview of the history of the project. The project objective was to replace exterior moldline chromated primer on the C-17, C-130, F-15, F/A-18, T-45TS, AV-8B, and Harpoon/SLAM weapon systems (see related article on page 3).

Mr. Larry Triplett gave an in-depth briefing of the final report of the operational tests (see related article on page 7). In summary, based on the cumulative results, all of the the operational testing of the two nonchrome primers have performed near but not equal in all cases to the chromate control primers. The results indicate that using nonchrome primers that perform in laboratory tests equivalent to the original test results for the Akzo Nobel, 10PW22-2 and PRC-DeSoto EWAE118 could meet operational performance requirements without adverse cost to the operational units. However, adhesion failures on the F/A-18, that began to appear on carbon epoxy wing skins after three years is a concern that needs to be addressed.

The JG-PP project was deemed completed at this point. The overall documentation to include the Final Test Report will be made available on the JG-PP web site. The nonchromate primers are qualified pending changes to both specifications. There was much discussion concerning “orange peel.” The concern with orange peel is on how it would be measured. With the high solid content in today’s primers, there is a higher incidence of this type of surface. The MAJCOMS are concerned that by allowing orange peel without stating specific parameters, inferior paint jobs will be encouraged.

Ms. Meredith began the discussions by asking for the general consensus on implementation of nonchromate primers. It was stated that the Air Force would not implement at least for 1 more year. There are still several areas that need further refining. Other Air Force concerns were discussed at the Air Force only meeting held on 31 Jan 02.

Mr. Steve Spadafora, NAVAIR, stated there is a possibility of the Navy using nonchromate primers on exterior moldline. He also stated that when the nonchromate primers are implemented, they would state restrictions on areas that have not been tested. The Navy has concerns with composite surfaces. It is their belief there is enough feasibility of potential for using the technology. They will have several teleconferences to discuss then have a face-to-face meeting to determine implementation.

The meeting was concluded with the understanding the Navy was ready for implementation, but the Air Force needed additional time to address other concerns. A follow-on meeting was held on 31 Jan 02 to continue discussing the Air Force’s concerns. The meeting was then concluded.

For further information regarding this meeting, please contact Mr. Steve Finley at DSN 787-8090 or via e-mail at Steven.Finley@wpafb.af.mil.

Summary of Results From the Final Joint Test Report for the Nonchromate Primer for Aircraft Exterior

During the field evaluation, Akzo 10PW22-2/ECW119, a Type I water reducible, nonchrome primer was applied to portions of three F-15s, one Harpoon Canister, and four T-45s test units. PRCDeSoto EWAE118 A/B, a Type II (Type II is Low IR) water reducible nonchrome primer was applied to portions of one AV-8B, one F-15, one C-17, one C-130 and seven F/A-18s. The portions of the test units not primed with one of the nonchrome primers were primed with either a high solids, low VOC, primer or water reducible chromated primer. All of the mold line surfaces not primed with nonchrome test primer was primed with Type I chromated primer except the F/A-18 and AV-8B which require the use of Type II primer.

Results

After four and one half years of the six-year paint cycle, the F-15 aircraft test primers are performing comparable to the control primer. Except for isolated adhesion failures that were deemed to be related to pre-paint preparation the nonchrome primer has performed as well as the chromated primer. Only two corrosion sites were found on surfaces with nonchrome primer and one with the chromate primer. Both sites were minor surface corrosion.

The C-17 testing was monitored for seventeen months and there have been no systemic failures of the coating system during the test period. The only paint adhesion failures occurred with the original chromated primer and not with the test or control primer that was applied for the test. No corrosion was found during the test period.

The flight test period of twenty months on the C-130 has not presented any coating system failures that indicate the nonchrome primer will not meet performance requirements. Areas for concern were limited to peeling paint around the perimeter of access covers with the test and control primers and leading edge erosion that is more pronounced with the nonchrome test primer.

AV-8B testing was designed to evaluate heat resistance of the PRC-DeSoto EWAE-118 nonchrome test primer on substrates that are likely to exceed a service temperature 400 degrees F. After thirteen months and over 400 flight hours, there were no heat-related failures of the primer. In addition to the planned evaluation of heat resistance, the primer has also demonstrated adhesion to titanium and Carbon/BMI substrates without failure.

In the Harpoon missile canister tests, the nonchrome primer did not perform as well as the chromate primer. However, neither of the test canisters performed well relative to the non-test canisters that were subjected to the same environment. A comparison of the chromate test canister to the non-test canisters indicates that the test did not accurately depict the performance that would be expected from a production application of nonchrome primer.

Overall results of the primer evaluation on interior and exterior surfaces of the T-45 test covers, after four years, indicate that the nonchromate test primer performance is similar to that of the chromate control primer. Minor corrosion and peeling paint around isolated fastener holes were not significantly different between the nonchrome and chromate primed surfaces. And, based on the assessment of the maintainers and inspection results the nonchrome test primer met the requirements for exterior maintenance touch-up on the T-45.

The F/A-18 testing provided the greatest challenge for measuring corrosion protection of nonchrome primer. Seven aircraft with nonchrome primer were deployed for two 6-month carrier deployments during the four-year test period. Overall there were more corrosion sites found during the inspections on the surfaces primed with nonchrome primer than on the corresponding chromate control areas. The findings were not consistent on every inspection and there was no unequivocal evidence that the differences were due solely to the nonchrome primer. However, it is likely that the lesser corrosion resistance properties seen in laboratory testing of the nonchrome primers are appearing after long term operational testing. Adhesion failures on the F/A-18 have been minor and not significantly different between the chromate and nonchrome primers for the first three years of the test. At the three and one half year inspection of one of the two aircraft that were stripped with PMB, adhesion failures began to appear on the composite surfaces of the upper wing and inboard vertical stabilizer. Adhesion failures of the nonchrome primer were more prevalent on the composite upper wing surfaces of both PMB stripped aircraft after completing the second deployment at four years.

Source: Joint Test Report

THE PROPULSION ENVIRONMENTAL GROUP HOSTS 10TH ANNUAL MEETING IN SAN DIEGO, CA

The Propulsion Environmental Working Group (PEWG) hosted its Winter 2002 Meeting in San Diego, CA from February 5 –7 2002. This meeting celebrated the 10th year since PEWG was first started and represented a major milestone for this group. Air Force, Army, and Navy personnel, as well as a cadre of Original Equipment Manufacturers (OEMs) attended the meeting. The presentation varied from an update on emerging regulations impacting the engine community to the latest advances in advance green technologies for gas turbine engine (GTE) repairs. Figure 2, on the next page, provides a listing of the presentations given at this conference.

Mr. Glen Graham, OC-ALC/LPPEE, was recognized for his ten years of contribution to the PEWG. Mr. Graham was one of the few original members that still are participating in the PEWG. According to Mr. Graham, ‘the PEWG bring together all the appropriate stakeholders, shares information, and provides quick resolution to issues.” Mr. Graham indicates that OC-ALC/LPEE’s participation in the PEWG has helped the Air Logistics Center (ALC) mover towards greener engine processes. “I continue to attend these meeting, because it is still, after ten year, the best resource for information on environmental issues for the engine community across DoD and industry.”

The next PEWG meeting is scheduled in July 2002 in Cincinnati, OH. For more information about the PEWG or to register for the next conference, please visit the PEWG web site at www.pewg.com.

Presentations at the PEWG Winter 2002 Meeting

February 5, 2002

- 1Lt Steven Elliott, PEWG Executive Officer
  Opening Remarks
- Sheldon Toepke, Boeing St. Louis
  Regulatory Issues Impacting Propulsion and Power
- LtCol James Byron, ASC/ENVV
  AF Aeronautical Systems Center Weapons System P2 Program
- Vankat Seetharaman, Pratt & Whitney
  Reclamation of Super Alloy Materials
- Admiral Ed Moore, Anteon San Diego
- Johnny Tsiao, OC-ALC/LPARR
  Green Technology Implementation under CIP
- Heather Moyer, CTC
  Lead Free Low VOC Anti-Galling Dry Film Lubricants (DFL), TWG Summary
- Colonel James Diehl, OC-LC/LPA
  Welcome, Keynote
- Steve Siens, JDMAG/JTEG
  Joint Technology Exchange Group (JTEG)
- Mike Rudy, PMA 265, NAVAIR PAX River
  F/A-18 Green Hornet Team Briefing
- Carl Loden, PEWG Management Office Anteon Corp.
  Hazardous Material Identification and Disposal
- Mike Scarberry, ASC/LPJ
  Aircraft Engine Component Improvement Program (CIP)
- Mark Rechtsteiner, GEAE
  Hot Engine Leak Test, (HELT) Final Results
- Lisa Cato, CTC
  Ion Beam & Plasma Based Alternatives to Chrome Plating for GTE Parts (MP4)

February 6, 2002

- Don Streeter, Aging Aircraft SPO
  Oil Reclamation
- Neal Werner, Pall, Inc.
  Pall Filtration Products
- Dick Myers, Aging Aircraft SPO
  ASC/AAA Aerospace Enterprise System Program Office
- Dr. Bob Wright, AFRL/PRTM
  AFRL Oil Monitoring & Reclamation Technologies
- Dennis Abbott, Pratt & Whitney
  H2O Jet Cleaning, Advanced Coating Technologies
- David Dumsha, NAVAIR 4.3.4.1
  Hard Carbon Coating
- Shanna Denny, CTC
  Sermetel Update
- Brian Stoll, NADEP Cherry Point
  Harrier Engine Filtration Program
- Craig Shaw, Hill AFB
  Hill AFB P2 Programs
- Wayne Ziegler, ARL
  Army Research Laboratory Technologies Related to the Propulsion Industrial Base
- Dr. Xu Li-Jones, NADEP North Island Anteon
  Engine Particulate Emission Measurements
- Stephen Gaydos, Boeing St. Louis
  Abrasive Engine Cleaning
- Gray Simpson, NADAP Cherry Point
  Erosion Resistant Coating
- Glen Welcher, Pratt & Whitney
  Pratt & Whitney Sermetal Project

February 7, 2002

- Chuck Alford, PEWG Management Office Anteon
  Introduction, Advanced Green Technologies for GTE Repair
- Gary Shubert, Pratt & Whitney
  Pratt & Whitney Green Repair Development Procedures and Opportunities
- Capt Chad Schroeder, JSF Program Office
  JSF Repair Concepts
- Bruce Sartwell, NRL - HCAT Chair
  HVOF PMR - Project Overview and Materials Testing
- Michael Linn, NADEP Jacksonville
  TF-34 & HVOF at NADEP Jacksonville
- Bob King, NADEP Cherry Point
  HVOF PMR-NADEP Cherry Point Component Verification
- Larry McCarty, ASAP, Peter Ruggiero, Englehard
  Feasibility Study: Fusing Thermal Spray Coatings with Electrospark Deposition (ESD)
- Mark Rechtsteiner, GEAE
  GEAE Green Repair Development Procedures and Opportunities
- Glen Graham, OC-ALC/LPPEE
  The Road to Cyanide Free Plating Shop
- Elaine Strock, Englehard
  Project Report - Off Angle HVOF Thermal Spray, Final Results
- Johnny Tsiao, OC-ALC/LPARR
  OC-ALC HVOF Capability
- Johnathan Dehart, NAVSEA
  Diesel Engine Emissions
- Rodrigo Romo, ZETA Corporation
  Electronic Deposit & Biofouling Control for Water Systems
- Bruce Sartwell, NRL
  HCAT Chair

Figure 2. PEWG Presentations

EXCERPTS FROM ADMIRAL ED MOORE'S SPEECH AT THE WINTER 2002 PEWG MEETING

" …Our ability to reengineer our force to meet the growing manning challenge that we have in this nation I think will soon become our greatest readiness issue. The force modernization has to reduce maintenance requirements and its associated cost. It must increase the reliability of equipment and it has to bring the products that we use, the capabilities that are delivered and that are employed out there in the operational world into the information age. It has to improve readiness and our combat capabilities, and it has to ensure that it adheres to federal and local laws. All of these criteria have to be applied to the solution sets that we have, that we have come up with in order for that combat force that you are supporting out there to feel the kind of results that are expected by the American population at large, by the American voter.

The kinds of things that you are attacking in this next four days in this working group as well as promote the flexibility needed to adapt to a changing job. We have to do a better job of integrating new technology into our forces. We have to do more to reduce the workload on our people through increased automation and the replacement and modernization of maintenance and defensive equipment. As I looked over your agenda, it looked to me like a lot of applications that you were seeking solutions for were focused just on the solution sets.

And I am very proud to see that the representatives from all across DoD, military and civilian as well as contractor here to get at those problems on your agenda. The end user's battle field is moving in that direction, toward jointness. So I would urge that in these working groups and your solutions you get joint solutions as fast as you can and help fuel the cultural change that has to take place that is required in order for this to occur. How can you do that? You can incorporate commercial technologies in your solution sets. Look to construct architectures that are broadly based and universally applicable across all of those solution sets. Be prepared to meet and except manufacturing standards. Seek solutions that reduce time to market, that is lead time implementation of your process product or result.

I challenge you that as you go through the next four days discussing the various problems that are outlined in your agenda that you do so with a focus on not just solving that particular problem for that particular application, but with a focus for what does this mean for the overall structure of our force, the direction that it is going and the way that the Department of Defense and our government will lead this nation into the century that we have embarked on, dare say the millennium that we have embark on…."

C-130 Paint Shop "Leans" Into Cutting Flow Days

Changes in the C-130 Hercules system program office paint shop here have reduced flow days, increased production and worker safety and saved $373,832 annually in the process.

The "Integrated lean repair" process helps organizations find better and more efficient ways of doing business, said Kenny Boutwell, a paint and de-paint shop supervisor. The system helped his shop reduce by one the number of flow days and reduce the amount of emitted environmental volatile organic compounds which means a safer place for workers to do their job.

"We've just scratched the surface," Boutwell said. "We've got along way to go but there are a lot of things we can do, a lot we have done and a lot we can do in the future."

Boutwell said he and his crew also reduced excess tools, materials and equipment by 39 percent; reduced the number of chemicals used from nine to three; and reduced storage space by 228 square feet. The shop began the ILR initiative in October on what is called a seven-day schedule of ball system "de-painting," he said. This means it took seven days for the aircraft to complete the de-painting process. With the help of new chemicals and better equipment, that schedule has now been reduced.

Boutwell said the "Six S" principal, which stands for safety, straighten, sort, scrub, standardize and sustain, is the basis of the system here.

"This basically means taking a really good look at yourself," he said.

"This was a real focused effort to take care of the items and initiatives that are crucial and important to the guys down here in this building," said Mike Watson, chief lean agent. "They're faced with a lot of chemical hazards, so the information about decreasing (volatile organic compounds) is very important for employees and the environmental concerns we're faced with everyday."

"One of the ways the system has worked so well is by getting workers on the floor involved in the process," Boutwell said.

"Suggestion forms were passed out to the workers and everyone (here) was briefed about (the system) and given the opportunity to ask questions or give suggestions," he said. "The participation from the floor has been great."

"Twenty four instructional classes were conducted on the lean system and, from those, 44 new initiatives or action items came from mechanics," Watson said.

"This gives the mechanics a chance to get their ideas and initiatives out in the open and we can get a team out to work them," he said. "Lean has a very high visibility right now; nothing lays around. If it's brought up, we have teams that work those initiatives and get the answers."

As a way to keep all employees informed, bulletin boards that plot the current status of the items being worked, and those that have been completed, are posted around the buildings. Employee suggestion forms, as well as monthly newsletters which feature those workers whose suggestions have been implement, are also available.

"There's a lot of feedback to the work force about what's going on (here) as far as the lean projects," Watson said. "Just these initial projects have really enhanced the mechanics to offer suggestions as well as management and branch chiefs. And that is a plus."

"Everybody in this shop put something forth in this effort, and that's really nice to see," said Boutwell.

Flashjet
Pollution Prevention on Supporting Production and the Warfighter

Current depainting of composite structures like radomes and other off-aircraft components involves either the use of hazardous methylene chloride and Methyl Ethyl Ketone and/or mechanical sanding, usually with a rotary disk. Both procedures impose serious environmental, safety, and occupational health (ESOH) risks. Always looking for ways to prevent pollution, improve worker conditions and provide the best possible service to the War Fighter, WR-ALC has identified and implemented new depainting methods.

Methylene Chloride is particularly hazardous to workers, as it is a known carcinogen and can inflict severe burns on contact with exposed skin. The environmental impact of depainting aircraft with methylene chloride is equally undesirable. Typically, it is estimated that WR-ALC will use approximately 21,000 gallons of methylene chloride per year while depainting composite structures. The use of Hazardous Materials (HAZMATs) contributes greatly to the hazardous paint sludge, which must be disposed of as toxic waste at ever increasing costs (currently as much as $1000.00 per 55 gallon. drum).

Mechanical abrasion, which is also part of the current depainting operations at WR-ALC, poses serious health risks for workers because of the release of toxic dust into the environment. As the paint is abraded away, fine particles of chromium and/or cadmium dust (inorganic hazardous air pollutants) are generated. Chromium dust contains strontium chromate – approximately 18% by volume. Chromium is a known carcinogen, which can cause lung cancer and has been known to cause bronchial asthma, nasal perforations, skin ulcers, and dermatitis. Cadmium dust is generated when cadmium plated parts such as fastener heads are subjected to mechanical abrasion. Cadmium is a probable carcinogen causing lung cancer and prostate cancer as well as kidney damage. The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations addressing paint stripping restrict inorganic hazardous air pollutants (HAP) emissions such as cadmium and chromium. Additionally, the Expanded OSHA Standard for Cadmium (existing) and the Expanded OSHA Standard for Chromium (pending) greatly reduce permissible exposure limits (PEL) in the workplace and trigger a number of costly requirements such as medical surveillance and years of record keeping when PELs are exceeded.

WR-ALC/TI and WR-ALC/EM initiated a program in 1996 to evaluate commercially available technology for use in radomes and other composite structures to eliminate the use of hazardous chemicals and/or mechanical sanding. As a result of this program, the FLASHJET system from Boeing was selected for implementation. In 1998, Boeing was contracted to install the FLASHJET system for WR-ALC. FLASHJET is a coatings removal system which uses pulsed light energy from a xenon flashlamp and dry ice pellet cleaning. The FLASHJET system is a prime example of Pollution Prevention. There are no inorganic HAPs generated and hazardous waste disposal is minimal to none. The environmentally compliant process uses no chemicals, as most current processes do, which have proven harsh on the composite substrates surfaces. FLASHJET also contributes a major step toward compliance with the NESHAP and Expanded OSHA Standards since no hazardous substances are used or created during the stripping process.

FLASHJET prototype installation and verification of system requirements were completed in March 2001. With the implementation of this system, WR-ALC has been able to remove coatings from radomes and composites without the need to use chemicals or hand sanding. Not only does the new method offer increased worker safety and prevents pollution, it also extends the life of valuable parts, ultimately saving valuable resources.

The Corrosion Program Office (CPO) Evaluates and Implements Environmentally Improved Materials and Processes in T.O. 1-1-8

The Corrosion Program Office conducted a project to identify, test, and evaluate environmentally advantaged materials and processes for inclusion in the T.O. 1-1-8. Additionally, procedures for performing work required in T.O. 1-1-8 and the equipment used were evaluated for improvement to limit and reduce worker exposure to hazardous materials and improve safety standards. Initially, the project evaluated and quantified the actual hazardous waste stream being generated from Air Force corrosion control operations. This data was then used to determine the focus for evaluating alternative materials and processes as well as their potential for reduction of hazardous material consumption and waste generation. A thorough analysis of all the materials and processes in T.O. 1-1-8 was accomplished and in-depth research done to identify more environmentally compliant alternatives.

As a result of this work, many new environmentally compliant materials, equipment to reduce exposure of personnel to hazards, and new and improved processes were identified, evaluated, and incorporated into the T.O. requirements. There was no accurate way to determine the full extent of the improvement for Pollution Prevention that was achieved, but it is extremely large and significant. There were too many improvements to list here, but the following are examples of things that met P2 improvement metrics and were ultimately implemented in T.O. 1-1-8 as a result of this project are summarized in Figure 3 on the next page.

This was one of the most significant P2 projects in accomplishing overall reductions in consumption of hazardous materials, hazardous waste generation from painting operations, and personnel exposure to hazardous materials. It has significantly improved the overall guidance in accomplishing depainting/painting operations and the criteria for performing these operations throughout the Air Force.

For further information regarding this effort, please contact Mr. Dave Ellicks at DSN 468-3284.

Successful P2 Implementations to T.O. 1-1-8 (Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment

- The approval and authorization of Flashjet for paint removal on aerospace and non-aerospace equipment. This method of paint removal reduces the waste stream to almost nothing compared to traditional chemical or plastic media paint stripping operations.
- After review of successful field testing of non-chromate tie coats (Aeroglaze 974x) conducted by the Air Force Corrosion Program Office (AFCPO) and Coatings Technology Integration Office (CTIO), procedures and authorization for their approval and use were added to the T.O. This has eliminated the requirement to use chromate laden primers when performing a scuff sand and overcoat painting of any ground support equipment or aircraft.
- Procedures on surface preparation for painting were added to require the use of HEPA vacuums, use of touch up chromate conversion coating pens and wipe on and wipe off chromate conversion coating procedures.
- Requirements were removed from the T.O. for many non-compliant (VOC and HAP) paints and replaced with alternative compliant materials.
- Authorization and procedures for using environmentally compliant solvents and paint thinners were developed and implemented. This has resulted in significant reduction in the use of MEK and other high VOC and HAP solvents in preparation for painting, such as pre-paint wipe down, and painting operations.
- Tables establishing minimum standards for personal protective equipment during depainting, surface preparation for painting, and painting operations were developed with the assistance of EOSH personnel at Brooks AFB. These were implemented and now establish a baseline of protection for all personnel involved in all aspects of painting operations.
- An appendix to the T.O. was developed and implemented to provide procedures for field level testing and shelf life extension of paints. This was previously only possible through laboratory testing and due to small quantities of materials at field level activities it was not cost effective to send them off to a laboratory for testing. The result was materials were routinely disposed of as hazardous waste rather than determined to be still usable and consumed.
- Alternative paint touch up procedures were developed and implemented. These consisted of the use of Sempens that are touch up brushes with self-contained two component paint materials, such as polyurethanes and epoxy paints and primers. Procedures were added for touching up paints using brushes and rollers that were not previously permitted for use on aircraft. These procedures reduce the use of spray equipment, mixing excessive amounts of materials and their disposal, and clean up of paint equipment, allow touch up painting to be performed in places other than paint booths and special facilities, and limit personnel exposure to hazardous materials.

Figure 3. Successful P2 Implementations to T.O. 1-1-8

Air Force Corrosion Office Investigates Plastic Blast Media (PMB) Contamination

Technical order (T.O.) 1-1-8 "Application and Removal of Organic Coatings, Aerospace and Non-Aerospace Equipment" prohibits using plastic media that has been used to remove paint from steel equipment to also be used for removing paint from aluminum equipment. In addition, T.O. 1-1-8 limits the amount of dense particle contamination in PMB to 0.02% for aerospace equipment and 0.2% for non-aerospace equipment. These are mandatory requirements that when complied with cause most organizations to change their media more frequently, consuming more media and generating more hazardous waste. The Air Force Corrosion Program Office in implementing a two phased project to address this issue.

The first phase of the project was to investigate the implications of the requirements and substantiate gains to be achieved through improvements in dense particle contamination separation technology.

The requirement to change media relative to the substrate being blasted is based on the 1989 Battelle report on dense particle contamination. The report found severe degradation in fatigue strength of aluminum substrate materials beyond their designed values due to dense particle contamination. Additionally, it is to prevent steel particles from becoming embedded in the softer aluminum substrate and leading to galvanic corrosion of the aluminum. To insure the dense particle contamination does not exceed prescribed levels, testing must be performed at least every 80 hours of operation for aerospace equipment and 800 hours for non-aerospace equipment.

Phase I of this project set out to identify whether or not a problem existed with media contamination and if so to what extent and the implications this would have on hazardous waste disposal. Significant problems were identified with both ferrous and dense particle contamination. Twenty percent of the samples taken from Air Force PMB equipment were found to have greater than 50 times the allowable dense particle contamination allowed by T.O. 1-1-8. The majority of shops tended to own only one PMB booth, which was used to blast both steel and aluminum parts. Of these, only a small percentage had a magnetic separator for removing ferrous contamination in the media and they were not complying with T.O. requirements for testing and changing media. The Phase I study found that proper adherence to technical order requirements would result on average in a ten-fold increase in PMB consumption. Since the release of the Phase I report, the AFCPCO has issued an operational safety supplement to T.O. 1-1-8 requiring compliance with media testing requirements or the plastic media blasting equipment will not be permitted for use to remove paint from aerospace equipment. Additionally, if the dense particle contamination exceeds the established levels, the testing frequency must now be increased and the blasting media replaced. This was necessary to prevent serious damage to Air Force equipment that could lead to loss of life.

The results of Phase I have now generated mandatory compliance with process controls that are reducing damage to Air Force equipment. It has shown the dramatic need for improved capability for dense particle separation to improve the ability to extend the use of PMB media and facilitate the more productive use of the equipment.

Phase II will identify, test, and evaluate methods to remove dense particle contamination during blast booth operations thus avoiding PMB waste generation every time the operator changes the material substrate being stripped. It will reduce test failures for dense particle contamination and provide for longer use of the media. The separation methods identified will allow maintenance personnel to maintain compliance with technical order requirements while reducing the required frequency of dense particle contamination testing and replacement of the media. This should result in an annual cost avoidance of approximately $10 million in the procurement and disposal of plastic media.

For further information regarding this project, please contact Mr. Dave Ellicks at DSN xxx –xxxx.

Leading Edge Technology: The Joint Group on Pollution Prevention (JG-PP) is Demonstrating Affordable Hand Held Laser Coating Removal Systems

Historically, mechanical or chemical based processes have been used to remove protective coatings. Lasers represent a leading edge technology to supplement existing depainting processes for stripping components, small areas, aircraft and ground vehicles. As shown in Figure 4, the layer of contamination on the surface absorbs the light emitted by the laser. The strong energy absorption creates a plasma, which expands, creating a shock wave. The shockwave fragments and ejects the contamination. The light is sufficiently short to avoid thermal phenomena, which could otherwise damage the surface to be treated.

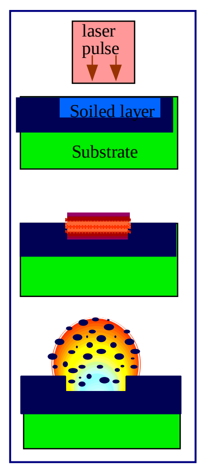


Figure 4. Physical Principals of Laser Technology

This article summarizes the evaluation of laser technology under the Joint Group on Pollution Prevention (JG-PP) Laser Coating Removal Project.

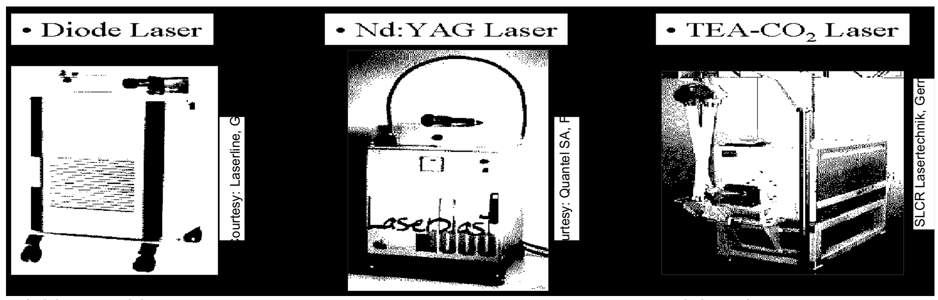
Overview of the JG-PP Laser Coating Removal Project

Air Force Research Laboratory, Weapon System Logistics Branch (AFRL/MLQL) and Air Force Materiel Command's Logistics Environmental Branch (AFMC/LGP-EV) are currently implementing an Environmental Security Technology Certification Program (ESTCP) funded project to demonstrate a portable laser coating removal system. This project is being implemented through the JG-PP program and includes stakeholders from the Department of Defense (DoD), National Aeronautics Space Administration (NASA), and Original Equipment Manufacturers (Boeing Aerospace, Lockheed Martin Aircraft). The project will demonstrate the feasibility of using a compact, portable, low-powered, hand-held laser system on small areas, complex geometry, irregular surfaces and hard-to-reach areas on aircraft, components, and support equipment to remove their paint systems.

In 2000, the Portable Laser Coating Removal System (PLCRS) conducted site surveys at MCLB Barstow (Marines), Corpus Christi Army Depot (Army), Warner Robins Air Logistics Center (Air Force), and Jacksonville Naval Air Station (Navy) to baseline the existing depaint processes, and define representative strip rates and coating system requirements.

The Joint Test Protocol (JTP), which was developed with the stakeholders, defines the tests (including substrate, tests, criteria) to qualify alternate laser technologies. Various weapon system managers within the Air Force, Army, NASA, and Marines have endorsed the JTP.

The Potential Alternatives Report (PAR) has been also been completed and contains laser technology information on fifteen different laser companies. The stakeholder downselected four companies, and based on visits to the manufacturers, three commercially available laser technologies will be demonstrated and validated against the JTP requirements. The manufacturers of the selected technology included Laserline (Germany), Quantel (France) , and SLCR (Germany). Figure 5 summarizes the advantages associated with each of these three systems.



Highly Portable	Highly Portable	High Strip Rate
Lowest Cost	Low Cost	Medium Cost
Highly Maneuverable	Highly Maneuverable	Small or Large Area Stripping
Suited for Small Area Stripping	Suited for Small Area Stripping	
Adaptable for Glove Box Design	Adaptable for Glove Box Design	

Figure 5. Overview of the Selected Laser Technologies

Currently, the three lasers are being shipped to the Air Force Research Laboratory where further testing will be completed. The testing will determine which system can be best used on various substrates such as aluminum and composite surfaces. While the majority of the testing will be performed on 2024-T3 and 7075-T6 aluminum and graphite epoxy composite substrates, this program will also include steel, kevlar, metallic honeycomb core, and fiberglass epoxy panels. The test plan will examine laser depainting rates and analyze the effect(s) of the laser removal process through 4 paint/depaint cycles. Strip rate and temperature measurements will be determined for a host of different coating and substrate types. The coating will include epoxy polyurethane, CARC, powder-coatings, NASA-specific, APC, and Gemcoat chemistries. The test program will include damage assessments, and mechanical testing, including fatigue. An effluent analysis (air sampling) and safety review are part of the test program.

Laboratory evaluations and testing of the potential alternative technologies will be completed by October 2003. A Joint Test Report (JTR) will document the results of the laboratory testing. Once the laboratory testing is complete, the program will begin field evaluation testing with an estimated completion of October 2004 to determine the reliability and maintainability of the laser systems. A final Joint Test Report (JTR) will also be prepared, along with procurement specifications.

For further information regarding the Portable Laser Coating System Removal Project, please contact Ms. Debbie Meredith (Program Manager) at DSN 787-7505, Mr. Tom Naguy (Technical Lead) at DSN 986-5709, or Mr. Gerry Mongelli (Project Manager) at DSN 787-7693.

Chrysler Corporation Replaces Cadmium Fasteners with Dacromet

In 1991, the Chrysler Fastener Engineering began evaluating and testing existing finishing technologies for long term use that met the following requirements:

- Environmental acceptability (OSHA, EPA Requirements)
- Corporate Hygiene Acceptability (Internal requirements)
- Consistent coefficient of friction (torque at clamp load relationship)
- Bimetallic protection (steel and aluminum joints)
- Cost (cost effectiveness)
- Best technology (long-term usage)
- Voluntary Programs

Seventeen different coatings were evaluated and tested in accelerated evaluation and field conditions for corrosion resistance. Field-testing lasted up to 1.5 years. Various fastener sizes were coated and attached to plastic panels. These were mounted to vehicles and driven in different parts of the country and at Chrysler Proving Grounds. Panels of these screws were also tested in salt spray for 500 hrs per ASTM B-117.

Considering all factors, DACROMET 320 corrosion resistant coating with PLUS L sealer showed the best results as the most cost effective corrosion protection coating to replace cadmium on fasteners. Today, DACROMET 320 and PLUS L are the corrosion resistant coating specified in Chrysler's Engineering Process Standard PS-5873, used for fastener sizes from M6 through M12. Coatings are applied by Dip-Spin or Dip-Drain-Spin, or spray coated with air or electrostatic spray guns.

DACROMET 320 composition is a proprietary aqueous coating dispersion containing mixed metal oxides and metallic zinc and aluminum flakes. PLUS L is an aqueous inorganic clear sealer. The coating surpasses 400 hours resistance to salt spray (fog) and can meet 1000 hours specification. Compared to electroplated zinc-dichromate and cadmium at equal coating thickness, the DACROSEALING process featuring PLUS L topcoat can provide over three times the salt spray corrosion resistance.

For further information, please contact Andrew Pfifer at 440-285-2231 ext. 295.

Emerging Technology: Ion Vapor Deposited Sputtered Aluminum Process

The ion vapor deposited (IVD) Sputtered aluminum technology is currently being demonstrated/validated at Hill AFB. When proven, IVD-Sputtered aluminum can provide a solution to about 20-25% of landing gear parts repaired at Hill AFB that required cadmium plating on internal diameters. In addition, due to the dense nature of sputter aluminum coatings, the sputter aluminum coatings can also be considered as a replacement for IVD aluminum coatings, if improved performance can justify the cost of changing coating systems at the DOD repair depots.

Process Description

Sputtered aluminum is a physical vapor deposition process. A simplified explanation of the process is provided in Figure 6.

1) A working gas, such as argon, is injected into a vacuum chamber
2) Argon atoms then become positively ionized in a "glow discharge" electric field
3) Positive argon ions are accelerated to a negatively charged high purity aluminum target
4) High velocity argon ions impact the aluminum target and this atomic collision dislodges and ejects aluminum atoms
5) High velocity ejected aluminum atoms hit and adhere to the part to be coated in the vacuum chamber, and thus, after many collisions of aluminum atoms, an aluminum coating is formed on the part.

Figure 6. Sputtered Aluminum Process

In addition, the sputtering yield can be increased dramatically by adding a magnetic field to the aluminum rod to increase the rate of collisions of the argon ions with the aluminum target rod, and this process is called magnetron sputtering.

The magnetron sputtering process is of interest as a supplement to IVD aluminum because it can be used to coat parts with deep internal diameters, whereas, the IVD process can only apply an aluminum coating a short distance into the inside diameter (ID) of a part. This combined sputter/IVD process is performed on parts with internal diameters as shown in Figure 7.

1) Aluminum sputter target rod is inserted into the ID of part, and then the part, along with the sputter rod, is placed into the IVD coating chamber
2) IVD coating chamber is pumped down to a low vacuum pressure and then argon is added to maintain a certain low pressure range
3) Glow discharge cleaning is used to clean the ID and external surfaces of the part
4) Sputter aluminum coating is applied to the internal diameter
5) IVD aluminum coating is applied to the external surfaces
6) Part with aluminum coating on ID and external surfaces is removed from the coating chamber.

Figure 7. Combined Sputter/IVD Process

Sputter aluminum is similar to IVD; it is a vacuum process and would use much of the same IVD coating equipment that currently exists at Navy, Air Force and Army repair depots. The sputter aluminum coating is a dense, high-purity aluminum coating and because it is denser than IVD aluminum, sputter aluminum coatings do not require glass bead burnishing to densify the coating. This is a positive feature for sputter aluminum because it would be very difficult to glass bead burnish internal diameters of parts.

Laboratory tests have shown that sputter aluminum coatings, applied by the magnetron sputtering process, can meet and exceed the requirements in MIL-DTL-83488 (Detail Specification – Coating, Aluminum, High Purity), and have no affect on reducing the fatigue life of high-strength steel alloy, and the sputter aluminum process (like the IVD process) does not cause hydrogen embrittlement of high-strength steel. In addition, laboratory tests were also conducted to compare sputter aluminum coatings with IVD aluminum coatings, and the tests showed that sputter aluminum coatings were good as, or better than, IVD aluminum coatings with regards to corrosion resistance, adhesion of aluminum coating on steel, and adhesion of paint on the aluminum coating.

Applicability

Sputtered aluminum would serve as an excellent supplemental coating to IVD aluminum. The process can be performed in the same chamber as the IVD process with some modifications to accommodate the sputter probes. Changes to technical publications for aircraft repair would be minimal because sputter aluminum also meets MIL-DTL-83488 and most of the technical publications currently specify that MIL-DTL-83488 aluminum coatings can be used as a substitute for cadmium plating.

For further information about this technology, please contact Mr. Steve Gaydos at 314-233-3451.

THE MONITOR ON INTERNET

This issue of the MONITOR is available on the Internet at the ASC site (http://www.engineering.wpafb.af.mil/esh/news/news.htm#monitor). The current issue of the MONITOR is in a Portable Document Format (PDF) file which requires a reader program for viewing or downloading. The Adobe Acrobat reader is available for downloading at no cost.

Emerging Technology: Electroflotation

Currently, there are two main technologies used for recycling rinsewaters: ion exchange and membrane filtration. As manufacturing processes become more complex, though, there is a demand for alternative methods of treating industrial wastewater. Trionetics Inc., founded in 1989, specializes in providing cost effective water treatment solutions and is one of the first companies in the U.S. to offer a new technology called electroflotation.

The Acquisition Environmental Safety and Health Division of the Engineering Directorate Aeronautical Systems Center (ASC/ENVC), Wright Patterson Air Force Base (WPAFB), in cooperation with Trionetics Inc. and Raytheon Company, has studied this Russian technology developed at Mendeleyev University in Moscow to produce the first "electrofloter" in the U.S. Electrofloters have many uses, including:

- Groundwater decontamination
- Treating industrial wastewater
- Sewage treatment
- Wastewater reclamation
- Treatment for emulsion separation of oil and aqueous phases

Electroflotation technology uses small bubbles of gas to capture contaminant particles in wastewater and float them to the surface for removal. Electrodes are arranged at the bottom of an electrofloter tank, which is then filled with wastewater containing dispersed solids. Bubbles of pure hydrogen and oxygen gas are produced as current is passed through the electrodes and water is broken down through hydrolysis. These hydrogen and oxygen gas bubbles rise through the wastewater solution attaching to insoluble contaminant particles, such as hard to treat metals and organic substances. A foamy layer, called flotosludge, gathers at the surface and is separated from the purified water by mechanical skimming or other means. The flotosludge is then collected for disposal.

Electroflotation has several advantages over other dissolved air floatation methods:

- The gas bubbles, being generated directly from water at the electrode surfaces, are pure and uncontaminated.
- Production of gas bubbles is directly proportional to the current through the electrodes. Therefore, the amount of gas generated can be controlled by varying the current through the electrodes.
- The equipment is simple, has few moving parts, and is easy to maintain.

The Raytheon Company, at U. S. Air Force Plant 44 in Tucson, Arizona, has successfully installed an electrofloter which operates in a "waterfall" lacquer paint booth in the TOW Missile Assembly Area. Electroflotation technology for removal of aluminum from wastewaters has been demonstrated at Cleveland Advanced Manufacturing Practices (CAMP) and will be implemented in Plant 44. Finally, a recycling system, consisting of an electrofloter provided by Trionetics, and an evaporator unit provided by PSI Water Systems, is being installed at Plant 44 to recycle laboratory wastewater. This water will be recycled to cooling towers, humidifiers, and boilers as required.

For further information, please contact Mr. Richard Lantis at ASC/ENVC at (937) 255-3054 x 424 or Richard.Lantis@wpafb.af.mil.

Ongoing SERDP R&D P2 Projects

Project #	Project Title/Objective	Contact
Air Emissions		
PP-1109	Non-Polluting Composites Remanufacturing and Repair for Military Applications ➨ This project seeks to research, develop, and demonstrate a unique, affordable, and environmentally friendly family of ploymer-matrix composite (PMC) manufacturing and repair technologies for stand-alone repair of current, soon-to-be-fielded, and future DoD structures.	Dr. James M. Sands Army Research Laboratory AMSRL-WM-MB 410-306-0878 jsands@arl.army.mil
PP-1113	Sol-Gel Technology for Low VOC, Non-Chromated Adhesive & Sealant Applications ➨ The primary objective is to develop and transition processes that eliminate the VOCs, chromates, and strong acids typically found in the metal surface treatment and priming steps conducted prior to application of adhesives and/or sealants. Secondary objectives include the reduction of hazardous wastewater streams associated with current processes and an improved performance compared to these processes.	Mr. James Mazza Air Force Research Lab AFRL/MLSE 937-255-7778 mazzajj@ml.wpafb.af.mil
PP-1118	Supercritical Fluid Spray Application Process for Adhesives and Primers ➨ The objective of this project is designed to provide the DoD with an adhesive application spray process that will minimize VOC emissions and reduce the costs associated with the use of organic solvents.	Dr. Marc Donohue John Hopkins University Department of Chemical Engineering 410-516-7761 mdd@jhu.edu
PP-1135	Primerless RTV Silicone Sealants/Adhesives ➨ The objective of this project seeks to develop, evaluate, and transition a primerless, self-bonding low temperature curable addition cured silicone that eliminates the use of high VOC primers without compromising durability, compatibility, thermal resistance, and long-term stability.	Mr. Dean Martinelli U.S. Army TACOM-ARDEC AMSTA-AR-WEA 973-724-5333 dmartin@pica.army.mil
PP-1139	Non-Structural Adhesives Requiring No VOCs ➨ The objective of this project is to develop innovative polymers that will serve as a viable alternative to current high VOC, non-structural adhesives.	Ms. Joan Combie Montana Biotech Corporation 406-388-0942 montana@montanabiotech.com
PP-1179	Reduced Particulate Matter Emissions for Military Gas Turbine Engines Using Fuel Additives ➨ The technical objective of this project is to identify and develop one or more additives for JP-8, JP-5, and diesel fuels that will reduce both the mass Emissions Index (mass EI = grams of PM2.5 emissions/kilogram of fuel) and the number density Emissions Index (number density EI = particle number density/kilogram of fuel) of PM2.5 at the exhaust exit of military gas turbine engines by 70 percent. The fuel additive should furthermore be benign to the environment, cost no more than $0.10 per gallon of fuel, and have no impact on the engine life of performance.	Dr. Mel Roquemore Air Force Research Laboratory 937-255-6813 melr@ward.appl.wpafb.af.mil

Ongoing SERDP R&D P2 Projects (continued)

Project #	Project Title/Objective	Contact
Air Emissions- continued		
PP-1181	Environmentally Compliant Sprayable Low Observable Coating that Facilitate Rapid Removal and Repair ➨ The overall technical objective of the proposed effort is to develop a MILSPEC-compliant RAM coating that contains no VOCs and no HAPs. Foster-Miller's No-VOC binder resin will be combined with Boeing's RAM filler to obtain a sprayable formulation that can cure rapidly using ultraviolet irradiation, reducing the application time significantly.	Dr. Robert Kovar Foster-Miller 781-684-4114 bkovar@foster-miller.com
PP-1184	Electrostatic Fuel Atomization for Gas Turbine Engines ➨ The purpose of this project is to develop electrostatic fuel atomization technology to achieve an 80 percent reduction in PM2.5 emissions from military gas turbine engines.	Dr. David Guimond Naval Surface Warfare Center Carderock Division 215-897-8641 guimonddp@nswccd.navy.mil
PP-1198	A NIST Kinetic Data Base for PAH Reactions and Soot Particle Inception During Combustion ➨ The purpose of this project is to develop a National Institute of Standards and Technology (NIST)-quality, gas-phase chemical kinetic database describing the transformation of fuel molecules to their desired end products of carbon dioxide and water, as well as to the undesired PAH, and to develop the first quantitative soot particle inception model based on experiments.	Dr. George WS. Mulholland National Institute of Standards and Technology Fire Science Division 301-975-6695 george.mulholland@nist.gov
PP-1198	A NIST Kinetic Data Base for PAH Reactions and Soot Particle Inception During Combustion ➨ The purpose of this project is to develop a National Institute of Standards and Technology (NIST)-quality, gas-phase chemical kinetic database describing the transformation of fuel molecules to their desired end products of carbon dioxide and water, as well as to the undesired PAH, and to develop the first quantitative soot particle inception model based on experiments.	Dr. George WS. Mulholland National Institute of Standards and Technology Fire Science Division 301-975-6695 george.mulholland@nist.gov
Elimination of Chrome and Cadmium		
PP-1074	Tri-Service "Green" Gun Barrel ➨ This project will develop a dry, environmentally clean replacement process for the existing aqueous electrodeposition chromium plating facility. This novel (non-aqueous) non-polluting process called the Cylindrical Magnetron Sputtering (CMS) process.	Dr. John Vasilakis Benet Labs TACOM-ARDEC, CCAC 518-266-5692 vasilaki@pica.army.mil
PP-1075	Replacement of Non-Toxic Sealants for Standard Chromated Sealants ➨ The objective of this program is to develop non-chromated sealants that meet the requirements of MIL-S-81733C. This will be accomplished by formulating and testing candidate non-chromated sealants to achieve properties that are equivalent or superior to the properties of existing sealants. An additional objective is to reduce the VOC content of the replacement sealants by 65 percent or more.	Mr. Alan Fletcher AFRL/MLSA Systems Support Division 937-255-7481 alan.fletcher@ml.afrl.af.mil

Ongoing SERDP R&D P2 Projects (continued)

Project #	Project Title/Objective	Contact
Elimination of Chrome and Cadmium - continued		
PP-1119	Critical Factors for the Transition from Chromate to Chromate-Free Corrosion Protection ➨ This project attempts to acquire a fundamental understanding of the chemical and physical processes and mechanisms of corrosion protection provided by chromate-based coatings applied to metal surfaces. A specific focus will be placed on corrosion protection of aluminum alloys.	Dr. Rudolph Buchheit Ohio State University Dept. of Materials Science and Engineering 614-292-6085 buchheit.8@osu.edu
PP-1147	Electro-Spark Depostied Coatings for Replacement of Chrome Electroplating ➨ The objective of this project is to develop process control sensors, process parameters, equipment, and techniques using electro-spark deposition (ESD) to coat inside diameters and other difficult geometries with robust-wear and corrosion-resistant coatings that will replace current chromium electroplating applications.	Mr. Joseph Argento U.S. Army TACOM-ARDEC 973-724-2428 argento@pica.army.mil
PP-1148	Novel Conductive Polymers as Environmentally Compliant Coatings for Corrosion Protection ➨ This project seeks to remedy the environmental limitations of current chromate-containing corrosion-protection coatings using new CP coating materials as environmentally compliant formulations. When incorporated into a benign process for the application of these coatings, these materials will provide the Department of Defense community with an attractive alternative to current anti-corrosion systems.	Dr. Peter Zarras Naval Air Warfare Center 760-939-1396 zarrasp@navair.navy.mil
PP-1150	Electrodeposited Mn-Sn-X Alloys for Corrosion Protection Coatings ➨ This project seeks to develop novel, low-cost, and environmentally-benign electrodeposition processes for the production of alloy coatings based on manganese (Mn) and/or tin (Sn), which combine high-corrosion protection performance, good tribological behavior, and suitable mechanical properties and would thus continue realistic alternatives to cadmium.	Dr. Giovanni Zangari University of Alabama 205-348-7074 gzangari@coe.eng.ua.edu
PP-1151	Clean Dry-Coating Technology for ID Chrome Replacement ➨ This project of this project is to develop an ID coating technology for hard chrome plating replacement that is clean, useable for rebuilds, environmentally acceptable, and emenable to both the original equipment manufacturer and the depot maintenance production environments.	Mr. Bruce Sartwell Naval Research Laboratory 202-767-0722 sartwell@nrl.navy.mil
PP-1152	Electroformed Nanocrystalline Coatings: An Advanced Alternative to Hard Chrome Electroplating ➨ This project of this program is to develop and optimize an advanced nanoscale coating technology based upon the modification of environmentally-benign conventional electroplating techniques which will yield coatings that meet or exceed the overall performance and life-cycle cost of existing hard chromium electroplating.	Dr. Maureen Psaila-Dombrowski McDermott Technology, Inc. 845-351-4035 maureen.psaila-dombrowski@mcdermott.com

TOngoing SERDP R&D P2 Projects (continued)

Project #	Project Title/Objective	Contact
Elimination of Chrome and Cadmium - continued		
PP-1224	Corrosion Resistant Steels for Structural Applications in Aircraft ➨ The overall technical objectives of this project are to (1) explore appropriate processing standards for alloy production processes, component manufacturing processes, and overhaul and repair processes to provide the information required for manufacture of components of the alloy and (2) provide adequate test data for mechanical behavior, corrosion resistance, and embrittlement resistance and life cycle cost to prove the ability of the alloy to replace current, cadmium coated aircraft structural steels using standard manufacturing techniques.	Dr. Gregory B. Olson QuesTek Innovations LLC 847-425-8220 golson@questek.com
Reduction of Hazardous Materials/Solid Waste		
PP-1110	Genetic Enhancement of an Anti-Freeze Protein for Use as a Substitute for Ethylene Glycol for Aircraft Deicing ➨ The project proposes to genetically alter the *Dendroides canadensis* antifreeze protein gene in order to enhance its freezing point depression capabilities and increase its usefulness and value as an aircraft anti-icing agent.	Dr. John Henry Aspen Systems Inc. 508-481-5058, ext. 153 henry@aspensystems.com
PP-1111	Environmentally Advantaged Substitutes for Ethylene Glycol for Aircraft Ice Control ➨ The technical objective of this program is to develop a high performance, environmentally benign aircraft anti-icing fluid which can be safely released to the environment without capture, control, and post-treatment of the runoff.	Ms. Carolyn Westmark Foster-Miller, Inc. 781-684-4119
PP-1117	Visual Cleaning Performance Indicators for Cleaning Verification ➨ This project seeks to identify, develop, and evaluate an operable inline/online cleaning performance verification method, consisting of a visual cleaning performance indication (VCPI) method that will accurately assess part cleanliness.	Dr. Bruce Monzyk Battelle Columbus 614-424-4175 monzyk@battelle.org
PP-1133	Mechanisms of Military Coatings Degradation ➨ Military coating systems are usually repainted for the following reasons: loss of appearance (aesthetics, camouflage, cleanliness); chipping, peeling, debonding of the coating; and corrosion of the substrate. The primary technical objective of this project is to identify, model, and predict degradation mechanisms that lead to military coating system failures and force depaint/paint operations to occur.	Dr. Steven McKnight Army Research Laboratory 410-306-0699
PP-1138	Cleaning Verification Techniques Based on Infrared Optical Methods ➨ The objective of this project is to develop real-time methods that provide both qualitative and quantitative assessments of surface cleanliness for a wide variety of military cleaning applications. Two prototype infrared-optical instruments with complementary capabilities will be built to aid in reducing the use, emission and handling of hazardous materials in cleaning operationsl	Dr. Shane Sickafoose Sandia National Laboratories 925-294-3526 smsicka@sandia.gov

Ongoing SERDP R&D P2 Projects (continued)

Project #	Project Title/Objective	Contact
Reduction of Hazardous Materials/Solid Waste - continued		
PP-1182	Ultraviolet Light Surface Treatment as an Environmentally Benign Process for Production, Maintenance and Repair of Military Composite Structures (SEED Project) ➨ The technical objective of this project is to develop a low-cost, high-speed, environmentally benign, dry surface treatment method for production and repair of military composite structures using ultraviolet (UV) light surface treatment in ambient air.	Professor Lawrence T. Drzal Michigan State University Composite Material and Structures Center 517-353-5466 drzal@egr.msu.edu
Green Energetics		
PP-1180	Castable, Solvent-Free Red Phosphorus Smokes for Target Markers ➨ This project will develop castable or pourable, chemically-cured RP formulations with sufficiently high binder content to totally eliminate the need for solvent processing aids, while concurrently mitigating electrostatic discharge (ESD) sensitivity.	Mr. Daniel Nielson Thiokol Propulsion 435-863-6687 nielsd1@thiokol.com
PP-1183	Investigation of MIC Materials for Electrically Initiated Lead Free Primers (SEED Project) ➨ The project will focus on validating the substitution of environmentally friendly metastable intermolecular composite (MIC) materials for lead currently used in the manufacture of electrically initiated 20mm primers.	Mr. Ron Jones Naval Air Warfare Center Weapons Division 760-939-7449 jonesrw@navair.navy.mil
Next Generation Fire Suppression		
PP-1059	Next Generation Fire Suppression Technology ➨ The objective of the Next Generation Fire Suppression Technology Program (NGP) is to develop and demonstrate, by 2005, technology for economically-feasible, environmentally-acceptable and user-safe processes, techniques, and fluids that meet the operational requirements currently satisfied by halon 1301 systems in aircraft.	Dr. Richard G. Gann National Institute of Standards and Technology 301-975-4052 rggann@nist.gov

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